

SECTION 701 AGGREGATES

701.01 AGGREGATE FOR CONCRETE. These specifications describe the quality and size of fine and coarse aggregate for portland cement concrete pavements and bases, highway bridges, and incidental structures.

The following test methods are used to evaluate the quality of aggregates for concrete:

Fineness Modulus of Fine Aggregate	AASHTO M 6
Sieve Analysis for Fine and Coarse Aggregate	MT-202
Wear Test	MT-209
Soundness	AASHTO T 104
Mortar-Making Properties	AASHTO T 71
Organic Impurities	AASHTO T 21
Coal and Light Particles	AASHTO T 113
Clay Lumps	AASHTO T 112
Petrographic Examination	*2-456-1

*Test method available from Materials Bureau

When wear factors are specified in the Contract, the term "aggregate surfacing" includes the coarse aggregate for concrete.

701.01.1 Fine Aggregates For Concrete.

- A. General Requirements.** Fine aggregate is natural sand having hard, strong, durable particles meeting the gradation requirements in Table 701-2.

Other approved inert material with similar characteristics or combinations of the above materials may be used, if the materials meet these specifications.

Do not mix or store in the same pile fine aggregate from different sources or use alternately in the same class of construction or mix without the Project Manager's written permission.

The deleterious substances and soundness specified in (B) and © below will be waived for aggregate used in structures or portions of structures not exposed to weather.

- B. Deleterious Substances.** Meet the deleterious material limits in Table 701-1.

**TABLE 701-1
LIMITS ON DELETERIOUS MATERIAL
IN FINE AGGREGATE**

MATERIAL	MAXIMUM % BY Wt
Coal and Lightweight Pieces	1.00
Clay Lumps	1.00

The material must not contain other deleterious material, such as shale, alkali, mica, coated grains, and soft, flaky particles.

- C. Soundness.** When fine aggregate is subjected to 5 cycles of the sodium or magnesium sulfate soundness test, the total corrected loss cannot exceed 10 and 15 percent by weight respectively.
- D. Organic Impurities.** Aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the standard will be rejected unless the aggregates pass the mortar strength test specified in (E) below. Do not use aggregates showing a darker color than that of samples originally approved for the work until tested to determine whether the increased color indicates an harmful quantity of deleterious material.
- E. Mortar-Making Properties.** The fine aggregate, when mixed with Type I or II cement and tested using the mortar making property test, must develop at 7 days, a minimum compressive strength of 95% of the strength developed by a mortar made with the same cement under AASHTO T 71.
- F. Grading.** The gradation requirements in Table 701-2 are the outer acceptance limits for use from all supply sources. The gradation must be uniform from any one source and not change from the low to the high gradation limits.

The fineness modulus of samples taken from proposed sources must be a minimum 2.50 and a maximum 3.10 when tested under AASHTO M 6. Fine aggregate from a source with a fineness modulus variation greater than plus or minus 0.20 from the design fineness modulus of the sample may require a concrete mix redesign. Applying the 0.20 variation will not permit the fineness modulus to be less than 2.50 or more than 3.10.

**TABLE 701-2
TABLE OF GRADATIONS - FINE AGGREGATE FOR CONCRETE**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 8 (2.36 mm)	80-100
No. 16 (1.18 mm)	50-85
No. 30 (0.600 mm)	25-60
No. 50 (0.300 mm)	5-30
No. 100 (0.150 mm)	0-10
No. 200 (0.075 mm)	0-3

A maximum 45% of the fine aggregate can be retained between any two consecutive sieves.

701.01.2 Coarse Aggregate For Concrete.

- A. General Requirements.** Coarse aggregate is crushed stone, gravel, or blast-furnace slag having hard, strong, durable pieces, free from adherent coatings. Other approved inert materials with similar characteristics or combinations of the above materials may be used, provided they meet these specifications.

The limits for deleterious material and soundness specified in (B) and © below will be waived for aggregate used in structures or portions of structures not exposed to the weather.

- B. Deleterious Substances.** Meet the deleterious material limits in Table 701-3.

**TABLE 701-3
LIMITS ON DELETERIOUS SUBSTANCES
IN COARSE AGGREGATE**

SUBSTANCE	MAXIMUM % BY Wt
Coal and Lignite	1.00
Clay Lumps	0.25
Soft Fragments	5.00
Thin or elongated pieces having a length greater than five times average thickness	15.00
Material passing the No. 200 sieve	* 1.00

*In crushed aggregates, if the material finer than the No. 200 sieve consists of fracture dust essentially free from clay or shale, the maximum limit may be increased to 1.5 percent.

The material must not contain other deleterious material, such as shale, alkali, mica, coated grains, and soft, flaky particles.

C. Soundness. When the coarse aggregate is subjected to 5 cycles of the sodium or magnesium sulfate soundness test, the total percentage loss cannot exceed 12 and 18 percent by weight respectively.

D. Percentage of Wear. Furnish coarse aggregate having a wear factor not exceeding 40 percent.

E. VACANT.

F. Grading. Furnish 1½-inch (37.5 mm) aggregate meeting the gradations in Table 701-4 for No. 4 (4.75 mm) to 1½-inch (37.5 mm), furnished in two separate sizes respectively meeting the gradations for No.4 (4.75 mm) to ¾-inch (19 mm) and ¾ to 1½-inch (19 mm to 37.5 mm) size material.

Furnish ¾-inch (19 mm) aggregate meeting the gradations for No 4 (4.75 mm) to ¾-inch (19 mm) material.

Furnish coarse aggregate uniformly graded between the limits specified in Table 701-4.

The aperture shape used for coarse aggregate acceptance has no relation to the size and shape of the aperture or screen type used in producing the material.

**TABLE 701-4
TABLE OF GRADATIONS - COARSE AGGREGATE FOR CONCRETE**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES DESIGNATED SIZES				
SIEVE	(NO. 1) No. 4 to	(NO. 2) No. 4 to	(No. 3) No. 4 to	(No. 4) No. 4 to
SIZE	1 ½" (37.5 mm)	¾" (19 mm)	1 ½" (37.5 mm)	½" (12.5 mm)
2" (50 mm)	100		100	
1½" (37.5 mm)	95-100		90-100	
1" (25 mm)		100	20-55	
¾" (19 mm)	35-70	90-100	0-15	100
½" (12.5 mm)				90-100
⅜" (9.5 mm)	10-30	20-55	0-5	40-70
No. 4 (4.75 mm)	0-5	0-10		0-15
No. 8 (2.36 mm)		0-5		0-5

Note: Nos. 1, 2, 3, and 4 correspond to AASHTO/ASTM designations 467, 67, 4, and 7 respectively

701.02 AGGREGATE FOR SURFACING.

701.02.1 General Requirements. The following test methods, as applicable, are used to evaluate the surfacing aggregate quality:

Sieve Analysis For Fine And Coarse Aggregate	MT-202
Wear Test	MT-209
Liquid Limit, Plastic Limit, Plasticity Index	MT-208
Fracture	MT-217
Volume Swell of Bituminous Mixtures	MT-305
Cleanness Value	MT-228
Petrographic Examination	2-456-3*

*Test method available from Materials Bureau

Furnish aggregate surfacing materials free of deleterious material except as permitted in Table 701-5.

Do not use scoria (fired clay commonly found in conjunction with burned coal in the lignite fields of the state) as aggregate to be bituminized. Sources of scoria are common but not limited to Daniels, Sheridan, Roosevelt, McCone, Dawson,

Prairie, Wibaux, Custer, Fallon, Rosebud, Treasure, Bighorn, Powder River, and Carter counties.

Meet Table 701-5 limits.

**TABLE 701-5
LIMITS ON DELETERIOUS SUBSTANCES
IN AGGREGATE SURFACING**

Substance	Maximum % by Wt*
Clay Lumps, Shale, Coal	1.5 each
Soft Particles	3.5 each

* Determined by Test Method 2-456-3

No combination of shale, clay, coal, and soft particles can exceed 3.5 percent. The aggregate must not contain wood and other plant material.

The portion of the aggregate retained on the No. 4 sieve is coarse aggregate, and that passing the No. 4 sieve is fine aggregate.

When wear factors are specified in the Contract, the term "aggregate surfacing" includes all aggregates specified in Subsections 701.02.4 through .9.

701.02.2 Select Surfacing. Furnish select surfacing, including added binder or blending material, meeting Table 701-6 gradation requirements.

**TABLE 701-6
TABLE OF GRADATIONS - SELECTED SURFACING**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES						
SIEVE SIZE	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
4"(100 mm)	100					
3"(75 mm)		100				
2½"(63 mm)			100			
2" (50 mm)				100		
1½"(37.5 mm)					100	
1" (25 mm)						100
No.200 (0.075)	15max	15max	15max	15max	15max	15max

The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 30 and 6 respectively.

701.02.3 Sand Surfacing. Furnish sand surfacing meeting Table 701-7 gradation requirements.

**TABLE 701-7
TABLE OF GRADATIONS - SAND SURFACING**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
SIEVE SIZE	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1½" (37.5 mm)	100				
1" (25.0 mm)		100			
¾" (19.0 mm)			100		
½" (12.5 mm)				100	
No.4 (4.75 mm)					100
No.10 (2.00 mm)	65 min	65 max	65 min	50 min	50 min
No.200 (0.075)	20 max	20 max	20 max	20 max	20 max

The liquid limit for the material passing the No. 40 sieve is 25 maximum, and the plasticity index cannot exceed 0.

701.02.4 Crushed Base Course Type "A". Furnish crushed base course type "A", including added binder or blending material, meeting Table 701-8 gradation requirements.

**TABLE 701-8
TABLE OF GRADATIONS - CRUSHED BASE COURSE TYPE "A"**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
SIEVE SIZE	Grade 2	Grade 5	Grade 6
4" (100 mm)	100		
3" (75 mm)	95-100		
2" (50 mm)		100	
1½" (37.5 mm)	80-100	95-100	100
1" (25.0 mm)			95-100
¾" (19.0 mm)	65-90	65-100	
½" (12.5 mm)			45-80
No. 4 (4.75 mm)	25-60	25-60	25-60
No. 10 (2.00 mm)	20-50	20-55	25-55
No. 200 (0.75 mm)	12 max	12 max	12 max

Meet the following requirements for crushed base course Type "A":

1. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 25 and 6 respectively.
2. Dust ratio limitations do not apply.
3. A wear factor not exceeding 50 percent at 500 revolutions.
4. Furnish binder meeting Subsection 301.02.2 requirements.
5. At least 25% by weight of the aggregate retained on the No. 4 sieve must have at least one mechanically-fractured face.

701.02.5 Crushed Base Course Type "B". Furnish crushed base course type "B", including added binder or blending material, meeting Table 701-9 gradation requirements.

**TABLE 701-9
TABLE OF GRADATIONS - CRUSHED BASE COURSE TYPE "B"**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
SIEVE SIZE	Grade 1	Grade 2	Grade 3
2" (50 mm)	100		
1½" (37.5 mm)		100	
1" (25 mm)	50-80		100
No. 4 (4.75 mm)	20-50	25-55	30-60
No. 10 (2.00 mm)			20-50
No. 200 (0.075 mm)	8 max	8 max	8 max

Meet the following requirements for crushed base course type "B":

1. The liquid limit for the fine aggregate passing the No. 40 must not exceed 35, while the plasticity index cannot exceed 10.
2. Dust Ratio: The portion passing the No. 200 sieve must not exceed two-thirds of the portion passing the No. 40 sieve.
3. A wear factor not exceeding 50 percent at 500 revolutions.
4. Up to 5% by weight of material one grade larger than that being produced is allowed. For example, when producing 1½-inch (37.5 mm) material, up to 5% of the total weight of material produced may be 2-inch (50 mm) material.
5. Furnish binder meeting Subsection 301.02.2 requirements.
6. At least 20 percent by weight of the aggregate retained on the No. 4 sieve must have one mechanically fractured face.

701.02.6 Crushed Top Surfacing Type "A". Furnish crushed top surfacing type "A", including added binder or blending material, meeting Table 701-10 gradation requirements.

**TABLE 701-10
TABLE OF GRADATIONS - CRUSHED TOP SURFACING TYPE "A"**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
SIEVE SIZE	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1" (25 mm)	100				
¾" (19.0 mm)		100			
⅝" (16.0 mm)			100		
½" (12.5 mm)				100	
⅜" (9.5 mm)					100
No. 4 (4.75 mm)	40-70	40-70	40-70	40-70	50-80
No. 10 (2.00 mm)	25-55	25-55	25-55	25-60	35-70
No. 200 (0.075 mm)	2-10	2-10	2-10	2-10	2-10

Meet the following requirements for crushed top surfacing type "A", including added binder or blending material:

1. Dust Ratio: the portion passing the No. 200 sieve cannot exceed two-thirds of the portion passing the No. 40 sieve.
2. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 25 and 6 respectively.
3. The composite aggregate shall not contain adherent films of clay and other matter that prevents thorough coating with bituminous material. Bituminous material shall remain adhered to the material upon contact with water.
4. When the aggregate is to be bituminized, both the material source and the composite aggregate shall have a volume swell not exceeding 10 percent and not show cracking or disintegration.
5. Do not remove intermediate sizes from the material during production, unless authorized in writing.
6. Have a wear factor not exceeding 50 percent at 500 revolutions.
7. At least 35 percent by weight of the aggregate retained on the No. 4 sieve must have at least one mechanically-fractured face.

701.02.7 Crushed Top Surfacing Type "B". Furnish crushed top surfacing type "B", including added binder or blending material, meeting Table 701-11 gradation requirements.

**TABLE 701-11
TABLE OF GRADATIONS - CRUSHED TOP SURFACING TYPE "B"**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
SIEVE SIZE	Grade 1	Grade 2	Grade 3
1½" (37.5 mm)	100		
1" (25 mm)		100	
¾" (19.0 mm)			100
½" (12.5 mm)			
No. 4 (4.75 mm)	40-80	40-80	40-80
No. 10 (2.00 mm)	25-60	25-60	25-60
No. 200 (0.075)	5-20	5-20	5-20

Meet the following requirements for crushed top surfacing type "B", including added binder or blending material:

1. Dust Ratio: the portion passing the No. 200 sieve cannot exceed two-thirds of the portion passing the No. 40 sieve.
2. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve must not exceed 35, while the plasticity index may vary from 3 to 10.
3. A wear factor not exceeding 50% at 500 revolutions.
4. At least 20 percent by weight of the aggregate retained on the No.4 sieve must have one fractured face.

701.02.8 Crushed Cover Aggregate - Cover Material. Furnish cover material meeting the gradation requirements of Table 701-12.

**TABLE 701-12
TABLE OF GRADATIONS - COVER MATERIAL**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
SIEVE SIZE	Grade 1A	Grade 2A	Grade 3A	Grade 4A	Grade 5A
5/8" (16.0 mm)	100				
1/2" (12.5 mm)		100	100		
3/8" (9.5 mm)	33-55	40-90	95-100	100	100
No. 4 (4.75 mm)	0-15	0-15	0-30	0-30	9-50
No. 8 (2.36 mm)	0-5	0-5	0-15	0-15	2-20
No. 200 (0.075 mm)	0-2	0-2	0-2	0-2	2-5

Meet the following requirements:

1. The material for Grades 1A through 4A must be non-plastic. For Grade 5A the liquid limit and plasticity index for the material passing the No. 40 sieve cannot exceed 25 and 6 respectively.
2. The composite aggregate must not have adherent films of clay, vegetable matter, frozen lumps, and other extraneous matter that prevents thorough coating with bituminous material. Bituminous material must remain adhered to the material upon contact with water. No combination of shale, clay, coal, and soft particles can exceed 1.5 percent.
3. A wear factor not exceeding 30 percent at 500 revolutions.
4. A minimum of 70 percent by weight of the coarse aggregate for Grades 1A through 4A must have at least one fractured face. A minimum of 50% by weight of the coarse aggregate for Grade 5A must have at least one fractured face.

701.02.9 Aggregate for Portland Cement Treated Base. Furnish aggregate for portland cement treated base, including added blending material, meeting Table 701-13 gradation requirements.

**TABLE 701-13
TABLE OF GRADATIONS - AGGREGATE FOR CEMENT-TREATED BASE**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
SIEVE SIZE	JOB MIX TARGET LIMITS
3/4" (19.0 mm)	100
No. 4 (4.75 mm)	40-70
No. 10 (2.00 mm)	25-55
No. 200 (0.075)	4-12

Meet the following requirements:

1. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve must be 30 and 7 respectively.
2. The material used to produce the aggregate must have a wear factor not exceeding 50% at 500 revolutions.

701.03 AGGREGATE FOR BITUMINOUS MIXTURES.

701.03.1 General Requirements. The following test methods will be used to evaluate the quality of aggregate to be bituminized:

Sieve Analysis For Fine And Coarse Aggregate	MT-202
Wear Test	MT-209
Liquid Limit, Plastic Limit, Plasticity Index	MT-208
Fracture	MT-217
Volume Swell Of Bituminous Mixtures	MT-305
Plastic Fines In Graded Aggregates	MT-213
Petrographic Examination	*2-456-2

*Test method available from materials Bureau

Aggregate for use in bituminous mixtures must not contain deleterious matter exceeding the percentages by weight determined by Test Method 2-456-2.

Do not use scoria (fired clay commonly found in conjunction with burned coal in the lignite fields of the state) as aggregate to be bituminized. Sources of scoria are common but not limited to Daniels, Sheridan, Roosevelt, McCone, Dawson, Prairie, Wibaux, Custer, Fallon, Rosebud, Treasure, Bighorn, Powder River, and Carter counties.

Meet the deleterious substances limits specified Table 701-14.

**TABLE 701-14
LIMITS ON DELETERIOUS SUBSTANCES
IN AGGREGATE FOR BITUMINOUS MIXTURES**

SUBSTANCE	MAXIMUM % BY Wt*
Clay Lumps, Shale, and Coal	1.5 each
Soft Particles	3.5 each

* Determined by Test Method 2-456-2

No combination of shale, clay, and soft particles can exceed 3.5 percent.

The portion of the aggregate retained on the No. 4 sieve is defined as coarse aggregate, and that passing the No. 4 sieve is defined as fine aggregate.

When wear factors are specified, the term "aggregate surfacing" includes all aggregates specified in Subsections 701.03.4 and .9.

701.03.2 Aggregate for Plant Mix Surfacing. Furnish aggregate for plant mix surfacing, including mineral filler when required, meeting Table 701-15 gradation requirements.

**TABLE 701-15
TABLE OF GRADATIONS - AGGREGATE FOR PLANT MIX SURFACING**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES				
GRADE A			GRADE B	
SIEVE SIZE	Job Mix Target Limits	Job Mix Tolerance	Job Mix Target Limits	Job Mix Tolerance
¾" (19.0)	100		100	
½" (12.5)	87-93	±8	86-90	±7
⅜" (9.5)	77-83	±8	75-79	±7
No. 4 (4.75)	52-58	±7	53-57	±7
No. 10 (2.00)	36-41	±6	34-40	±6
No. 40 (0.425)	19-21	±5	16-18	±5
No. 200 (0.075)	6-8	±2	5-7	±1

Meet the following requirements:

1. A wear factor not exceeding 40% at 500 revolutions using Montana Test MT-209.
2. For Grade A aggregate at least 50% by weight of the coarse aggregate particles must have at least one mechanically-fractured face. For Grade B aggregate at least 70% by weight of the aggregate must have at least one mechanically-fractured face.
3. The maximum liquid limit for the aggregate passing the No. 40 sieve is 25. The maximum plasticity index for Grade A aggregate is 6. Grade B aggregate must be non-plastic.
4. The final produced aggregate, including treated aggregate, must have a volume swell not exceeding 10% and cannot show cracking or disintegration.
5. The aggregate must not contain adherent films of clay and other matter that prevents thorough coating with bituminous material.

701.03.3 Aggregate for Open-Graded Friction Course. Furnish aggregate for open-graded friction course consisting of clean, hard, durable fragments of crushed stone or crushed gravel, plus filler fragments of finely crushed gravel, crushed stone, or sand meeting Table 701-16 gradation requirements.

**TABLE 701-16
TABLE OF GRADATIONS - AGGREGATE FOR OPEN-GRADED
FRICTION COURSE**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
SIEVE SIZE	PERCENT PASSING
3/8" (9.5 mm)	100
No.4 (4.75 mm)	30-50
No.8 (2.36 mm)	5-18
No.200 (0.075 mm)	2-5

Meet the following requirements:

1. At least 95% of the aggregate retained on the No. 4 sieve must have at least one mechanically-fractured face.
2. The liquid limit for the material passing the No. 40 sieve cannot exceed 25, and the plasticity index not exceed 0.
3. A wear factor not exceeding 30 percent.
4. The aggregate must not contain deleterious material that prevents thorough coating with bituminous material.

701.04 FOUNDATION AND BEDDING MATERIAL FOR STRUCTURES.

701.04.1 Bedding Material. Furnish bedding material for minor drainage structures and culvert foundations.

Furnish bedding material that is reasonably free of clay, silt, and other deleterious material and meets Table 701-17 gradation requirements.

**TABLE 701-17
TABLE OF GRADATIONS - BEDDING MATERIAL**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
SIEVE SIZE	PERCENT PASSING
4" (100 mm)	100
No.4 (4.75 mm)	25-60
No.200 (0.075 mm)	12 max

Note: Use minus 1½-inch (37.5 mm) aggregate in the top 3-inches (75 mm) of bedding material.

701.04.2 Foundation Material. Foundation material is one or more aggregate material courses to provide a stable foundation for culvert and drainage structure installations in unstable areas.

Use shot rock, pit-run aggregate, crushed aggregate, or any combination of these materials. The largest rock or rock fragment allowed may be as great in dimension as the thickness of the lift being placed. In the top 1 foot (305 mm) of the foundation, the largest rock or rock fragment cannot exceed 8-inches (200 mm). Use well-graded material in the top 1 foot (305 mm) of foundation material. A maximum 40 percent by weight of the foundation material must pass a No. 4 sieve.

701.05 FILTER MATERIAL. Furnish filter material meeting Table 701-18 gradation requirements.

**TABLE 701-18
TABLE OF GRADATIONS - FILTER MATERIAL**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES		
Sieve Size	Gradation No. 1	Gradation No. 2
2" (50 mm)		100
1½" (37.5 mm)		95-100
¾" (19.0 mm)		35-70
⅜" (9.5 mm)	100	10-30
No. 4 (4.75 mm)	95-100	0-5
No. 8 (2.36 mm)	80-100	
No. 16 (1.18 mm)	50-85	
No. 30 (0.60 mm)	25-60	
No. 50 (0.30 mm)	5-30	
No. 100 (0.15 mm)	0-10	

701.06 RIPRAP. Furnish stone that is hard, durable, angular in shape, resistant to weathering and water action, free from overburden, spoil, shale, structural defects, and organic material.

Each stone must have its greatest dimension not greater than 3 times its least dimension.

Do not use rounded stone or boulders from a streambed source as riprap. Do not use shale or stone with shale seams.

The stone will be accepted by the Project Manager based on visual analysis, the Department's Riprap evaluation form, or both. Submit samples at least 30 days before placing the riprap.

701.06.1 Handlaid Riprap. Furnish stone or rock fragment at least 3-inches (75 mm) thick, a minimum ½ cubic foot (0.014 m³) in volume, weighing at least 75 pounds (34 kg), excluding rock spalls.

Extend all stones and fragments through the revetment, except spalls used to chock larger stones and fill voids between the larger stones.

701.06.2 Random Riprap. Furnish the specified random riprap meeting Table 701-19 requirements.

**TABLE 701-19
TABLE OF GRADATIONS - RANDOM RIPRAP**

Class	Weight of Stone	Equivalent Spherical Diameter*	Percent of Total Weight That Must Be Smaller Than Given Size
I	100 lb (45 kg)	1.05 ft (320 mm)	100
	60 lb (27 kg)	0.88 ft (270 mm)	70 - 90
	25 lb (11 kg)	0.66 ft (200 mm)	40 - 60
	2 lb (0.90 kg)	0.27 ft (80 mm)	0 - 10
II	700 lb (318 kg)	2.00 ft (610 mm)	100
	500 lb (227 kg)	1.79 ft (545 mm)	70 - 90
	200 lb (91 kg)	1.32 ft (400 mm)	40 - 60
	20 lb (9.0 kg)	0.61 ft (190 mm)	0 - 10
III	2000 lb (09 kg)	2.82 ft (860 mm)	100
	1400 lb (35 kg)	2.53 ft (770 mm)	70 - 90
	700 lb (318 kg)	2.00 ft (610 mm)	40 - 60
	40 lb (18 kg)	0.77 ft (235 mm)	0 - 10

*Based on unit weight of 165 lb/ft³ (2 675 kg/m³)

701.06.3 Grouted Riprap. Furnish stone for grouted riprap meeting Subsection 701.06.2 requirements.

701.07 BANK PROTECTION. Furnish rock that is hard, dense, and durable. Use either quarried rock or natural coarse gravel. Rock may be obtained from adjacent roadway excavation. Do not use rock obtained from streambeds.

Furnish the specified bank protection meeting Table 701-20 requirements.

**TABLE 701-20
SIZE REQUIREMENTS - BANK PROTECTION**

TYPE	1	2	3	4
Nominal Thickness	24" (610 mm)	18" (460 mm)	12" (305 mm)	Coarse Gravel
Overall Thickness Including Bedding	30" (760 mm)	24" (610 mm)	18" (460 mm)	As Specified in the Contract
Largest rock Permissible	1/4 Cu Yd (0.19 m ³)	1/8 Cu Yd (0.09 m ³)	1 Cu Ft (0.03 m ³)	1/8 Cu Ft (0.003 m ³)
Smallest rock Permissible	1/10 Cu Ft (0.003 m ³)	1/10 Cu Ft (0.003 m ³)	1-1/2" (40 mm)	3/16" (5 mm)

701.08 SAND-GRAVEL CUSHION. Furnish sand-gravel cushion for concrete slope protection meeting Subsection 701.04.1 requirements for bedding material except that all the material must pass a 1½-inch (38 mm) sieve.

701.09 BACKFILL FOR METAL BIN-TYPE RETAINING WALLS. Furnish backfill for the bins specified by the bin manufacturer. If not specified, use a gravel-type soil with 95 percent passing the 2-inch (50 mm) sieve and not more than 10 percent passing the No. 200 sieve. The material volume swell cannot exceed 10 percent and must have a plasticity index not exceeding 10.

701.10 DRAIN AGGREGATE. Furnish drain aggregate that is rounded to sub-rounded aggregate meeting Table 701-21 gradation requirements.

**TABLE 701-21
TABLE OF GRADATIONS - DRAIN AGGREGATE**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	Percent Passing
6" (152 mm)	100
¾" (19 mm)	0-10
No.4 (4.75 mm)	0-5